

EXHIBIT C

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to development of the software of the CPU board which has a control section.

[0002]

[Description of the Prior Art] Drawing 6 is the block diagram showing the CPU board for explaining the development method of the conventional software shown in JP,56-132647,A, and in drawing, 1 is a personal computer (it abbreviates to a personal computer below), and consists of CPU2, RAM3, ROM4, a display 5, a keyboard 6, a cross compiler (software which compiles and creates the machine program of other CPUs) 7, and a CPU bus 8. 9 is a sub CPU board and consists of CPU10, the CPU control circuit 11, the bus selection section 12, the factice side CPU bus 13, a personal computer side CPU bus 8, a common bus 14, and a connection 15. 16 is a test CPU board and consists of CPU17, RAM18, ROM19, a control section 20, and a CPU bus 21.

[0003] Next, the procedure of development of software is explained. From test CPU board 16, CPU17 is removed and the connection 15 of sub CPU board 9 is instead connected to a CPU socket. The bus selection section 12 transmits the program by the side of [CPU / 17] a test created with the cross compiler 7 of a personal computer 1 to the test side RAM 18, where the personal computer side CPU bus 8 is chosen. Next, the bus selection section 12 makes a factice CPU 10 perform this program, where the factice side CPU bus 13 is chosen. The instruction from the keyboard 6 of a personal computer 1 is transmitted to a factice CPU 10 during sub CPU10 actuation in the sub CPU control circuit 11 connected to the personal computer CPU bus 8, and a factice's CPU 10 activation result is sent to the personal computer CPU bus 8 from the sub CPU control circuit 11, and is displayed on the display 5 of a personal computer 1.

[0004]

[Problem(s) to be Solved by the Invention] Since development of the conventional software was made as mentioned above, the cross compiler of dedication was required for the program development of a test CPU board, and the commercial compiler was not able to be used for it. moreover, in order to examine a test CPU board, the sub CPU board only for trials is required -- etc. -- there was a problem.

[0005] Without being made in order to solve the above technical problems, and

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using the self compiler of dedication, using the self compiler for personal computers, it is made to be possible [the software development of this invention], and it offers the development method of the software which does not need the sub CPU board for a trial.

[0006]

[Means for Solving the Problem] A development method of software concerning invention of this claim 1 connects the CPU bus 8 of a personal computer 1 to CPU board 30 for CPU board 30, develops software by the side of CPU board 30 with the self compiler 22 of a personal computer 1, is transmitted and installs it in a CPU board 30 side.

[0007] In invention of claim 2, in invention of above-mentioned claim 1, an artificial circuit of a standard input/output is established in the board side CPU bus 35, an inputting agency is used as the keyboard 6 of a personal computer 1, and an output destination change is used the display 5 of a personal computer 1.

[0008] By invention of claim 3, in invention of above-mentioned claim 1, the interrupt signal 45 from the control section 20 by the side of CPU board 30 is put into the board side CPU 31, and a control-section program is set to a common bus 36, and interrupt processing 44 is performed by board side, and it is made to perform usual processings 43 other than an interrupt by personal computer 1 side.

[0009]

[Function] In invention of claim 1, it compiles using the self compiler of a personal computer, the control-section program after this debugging is transmitted to the memory of a CPU board after the trial of an object program, and the completion of debugging, it considers as install, and actuation of a control section is enabled.

[0010] In invention of claim 2, when the control-section program compiled and created with the self compiler operates with a CPU board, a standard input/output serves as a display of a personal computer, and a keyboard.

[0011] In invention of claim 3, usual processing by the side of a personal computer is performed with reference to the work area which changes with board side interrupt processing to real time.

[0012]

[Example]

The example 1 of this invention is explained based on drawing below example 1. In drawing 1, 22 is the self compiler mounted in the personal computer 1. 30 is a CPU board and consists of CPU of 31, RAM of 32, ROM of 4, the bus selection section of 33, the control section of 20, a board side CPU bus of 35, a personal computer side CPU bus of 8, and a common bus of 36. The above-mentioned control section 20 is an interface for multiple-purpose, and has general-purpose I/O, DI/DO, and serial IO (module for a communication link). Moreover, the self compiler 22 is the thing of a commercial item, and the function for standard inputs/outputs and the ioctl function are prepared in addition to the below-mentioned printf function and the scanf function. Since ioctl only performs WRITE to READ and memory I/O to memory I/O fundamentally, it is necessary to make a control section 20 a DI/O interface, 2 port memory interface, etc.

[0013] Next, actuation is explained. With a personal computer 1, the program

which operates a control section 20 with the self compiler 22 is created. Next, a control section 20 is actually operated by loading to RAM3 and making it perform, and a program is debugged. A program is transmitted to the board side RAM 32 after debugging termination, and it is made to perform to the board side CPU 31. By the board and personal computer side, since the program environment over a control section 20 is the same also in hardware also by software, a control section 20 can be operated to a board side. That is, program manufacture is as following procedure I - HO.

It manufactures, although the program by manufacture of an I . source program, i.e., a high level language, was file-ized by the ASCII code. This manufacture is created by the personal computer [which was prepared for each OS] side to which the creation keyboard 6 and CRT5 are connected with the text editor. To the above-mentioned editor, VI editor is famous for MS-DOS in MIFES and UNTX.

b. Compile this software using the self compiler 22 after program completing by I, and manufacture an object program.

c. Memorize this object program to RAM3.

d. By CPU2 of a personal computer 1, access RAM3, use CRT5 and a keyboard 6, and they are the trial for control-section 20 drive, and debug-line **.

e. Mind CPU8, transmit to RAM32 and install the data after the completion of debugging, and in RAM3 in it.

In this case, since debugging using CPU31 is debugging ending, it is not necessary to perform it. The change of the bus selection section 33 is performed using a hardware switch. As mentioned above, with a self compiler, a source program is changed into an object program, the application for personal computers is created, this application absolute language is transmitted and installed in RAM32 from RAM3, and CPU31 is performed. Here, a commercial compiler creates the absolute language (object program) which realizes a function by carrying out by repeating OS system call of a personal computer. Generally, the CPU board **** case was making the system call of OS only on boards. Therefore, OS system call of the absolute language which the compiler for personal computers creates is not received. In addition, when CPU2 displays an alphabetic character on CRT, the absolute language which a self compiler creates only calls the system call of OS. However, the calling sequence (that is, AH is [02H internal-interruption vector number] 21H) of environment of the system call of this OS must be completely the same.

[0014] The example 2 of this invention is explained based on drawing 2 below example 2. However, the same thing as drawing 1 uses the same sign among drawing 2 . In drawing 2 , 30 is a CPU board and consists of CPU of 31, RAM of 32, ROM of 4, the board side CPU bus of 35, a personal computer side CPU bus of 8, a standard output artificial circuit of 40, and a standard input artificial circuit of 41. The standard output artificial circuit 40 and the standard input artificial circuit 41 are DO and DI. It carries out, it functions, and an example is a well-known circuit as it is shown in drawing 3 . Control is performed through CRT controller 70 and the keyboard controller 71 so that clearly from this drawing. In addition, 72 is a CRT bus and 73 is a keyboard bus. Thus, CRT controller 70 and the keyboard controller 71 are between a display 5 and a keyboard 6, and this etc. is controlled

by the standard output artificial circuit 40 and the standard input artificial circuit 41.

[0015] Next, actuation is explained. The program after the completion of debugging created with the self compiler 22 of a personal computer 1 like the example is transmitted and installed in the board side RAM 32, and it is made to perform to the board side CPU 31. When the standard output function (an equivalent for the printf function of C) of a program is performed, the board side CPU 31 outputs a result to the standard output artificial circuit 40, and the personal computer side CPU 2 carries out the display output of this output to personal computer side CPU bus 8 course and a display 5. Moreover, the personal computer side CPU 2 is always writing the input of a keyboard 6 in the standard input artificial circuit 41. When the standard input function (an equivalent for the scanf function of C) of a program is performed, the board side CPU 31 scans and incorporates the standard input artificial circuit 41. Therefore, a check of operation can be performed working with CPU board 30 using the display 5 of a personal computer 1, and a keyboard 6. That is, supply the data of a convention equivalent to having operated the keyboard 6 to CPU31 by the standard input artificial circuit 41, and CPU31 is made to drive, by displaying a result on a display 5 through a bus 8 by the standard output artificial circuit 40, verification of actuation is enabled and debugging is made easy. If the standard output artificial circuit 40 and the standard input artificial circuit 41 are used, the parameter of a keyboard 6 is only pushed and it can debug.

[0016] The example 3 of this invention is explained based on drawing below example 3. In drawing 4, 30 is a CPU board and consists of CPU31, RAM32, ROM4, the board side CPU bus 35, the personal computer side CPU bus 8, the standard output artificial circuit 40, the standard input artificial circuit 41, the bus selection section 33, a control section 20, the board side CPU bus 35, the personal computer side CPU bus 8, a common bus 36, RAM42, usual processing 43, and interrupt processing 44. 45 is an interrupt signal inputted into the board side CPU 31 from a control section 20.

[0017] Next, actuation is explained. A program is transmitted for the program of the control section 20 created with the self compiler 22 of a personal computer 1 to the board side RAM 42, and a control section 20 is examined by the personal computer side CPU 2. Processing 43 and interrupt processing 44 are usually linked to a control-section program, and it has become one load module. Since the close interrupt signal 45 from a control section 20 is in the board side CPU 31, the interrupt-processing section 44 is performed by the board side CPU 31. Usually, the personal computer side CPU 2 performs processing 43. Usually, since processing 43 and interrupt processing 44 are linked by the self compiler 22, usually refer to the work area in interrupt processing 44 for processing 43 easily. Thus, interrupt processing can be operated by the CPU board side, and trial effectiveness can be raised with combining with a control-section trial with a personal computer. Thus, although interrupt processing 44 is performed by CPU31, processing 43 is usually performed by CPU2 and an assignment is aimed at in this example, processing (processing of those other than interrupt processing) 43 and interrupt processing 44 are divided clearly, and the concrete

method for memorizing is usually performed by registering with a well-known interrupt vector, as shown in drawing 5. Thereby, by processing, interrupt processing is not usually CALL(ed). When address registration is carried out at an interrupt vector and an interrupt signal goes into CPU31, CPU31 carries out jump activation of the interrupt processing.

[0018]

[Effect of the Invention] As mentioned above, according to invention of claim 1, a personal computer performs program development for CPU boards and control-section trial, and debugging using a self compiler, and after debugging ending on a personal computer, since a program is transmitted to a CPU board and it was made to operate it to it, the efficiency of the program development of a CPU board can be increased.

[0019] Since a standard-input/output circuit is prepared and the standard-input/output program enabled it to operate by CPU by the side of a board according to invention of claim 2, a check of operation can be performed working with a CPU board using the display and keyboard of a personal computer, and a check of operation can be performed easily.

[0020] Since interrupt processing is operated by the CPU board side and it enabled it to usually perform processing by the personal computer side according to invention of claim 3, it can combine with a control-section trial with a personal computer, and trial effectiveness can be gathered further.

[Translation done.]